Claims

[c1] An infrared sensor comprising:

a frame formed of a semiconductor material that is not heavily doped;

a diaphragm having a perimeter supported by the frame, the diaphragm having a first surface for receiving thermal radiation and an oppositely-disposed second surface, the diaphragm comprising multiple layers including a first dielectric layer, a sensing layer that contains at least a pair of interlaced thermopiles, a second dielectric layer, and a first metal layer defining metal conductors that electrically contact the thermopiles through openings in the second dielectric layer, each thermopile comprising a sequence of thermocouples, each thermocouple comprising dissimilar electrically-resistive materials that define hot junctions located on the diaphragm and cold junctions located on the frame; and

signal processing circuitry on the frame and electrically interconnected with the thermopiles through the metal conductors defined by the first metal layer, the thermopiles being interlaced so that the output of a first of the thermopiles increases with increasing temperature difference between the hot and cold junctions thereof, and so that the output of a second of the thermopiles decreases with increasing temperature difference between the hot and cold junctions thereof.

[c2] The infrared sensor according to claim 1, further comprising a metal body within the diaphragm for reflecting infrared radiation through the second dielectric layer so as to increase absorption of infrared radiation and thereby increase the temperature at the hot junctions of the thermopiles.

[c3] The infrared sensor according to claim 1, further comprising a metal body within the diaphragm, surrounding the hot junctions of the thermopiles, and between the hot and cold junctions of the thermopiles, the metal body serving to promote equalization of temperatures at an inner edge of the metal body and the frame.

[c4] The infrared sensor according to claim 1, wherein the signal processing circuitry comprises means for on-chip calibration and means for nonlinear temperature

compensation responsive to changes in the temperature of the signal processing circuitry.

[c5] The infrared sensor according to claim 1, wherein the diaphragm has a rectangular shape with corners, the thermocouples being shortest at the corners and progressively increasing in length therebetween.

[c6] The infrared sensor according to claim 1, wherein substantially the entire diaphragm is occupied by either the thermopiles or a central heat-absorption zone surrounded by the thermopiles.

[c7] The infrared sensor according to claim 6, further comprising a metal body within the diaphragm and within the central heat-absorption zone for reflecting infrared radiation through the second dielectric layer so as to increase absorption of infrared radiation within the heat-absorption zone and thereby increase the temperature at the hot junctions of the thermopiles.

[c8] The infrared sensor according to claim 1, wherein the diaphragm has a rectangular shape, the infrared sensor further comprising a rectangular-shaped metal body surrounding the hot junctions of the thermocouples and between the hot and cold junctions of the thermocouples, the rectangular-shaped metal body serving to promote equalization of temperatures at an inner edge of the metal body and the frame.

[c9] The infrared sensor according to claim 1, wherein the diaphragm further comprises a second metal layer and a polysilicon layer, the second metal layer defining second metal conductors that interconnect the metal conductors of the first metal layer with the signal processing circuitry, the polysilicon layer defining polysilicon conductors in parallel with the second metal conductors of the second metal layer, the polysilicon and second metal conductors defining coaxial conductors that electrically interconnect the thermopiles with the signal processing circuitry.

[c10] The infrared sensor according to claim 1, wherein the diaphragm further comprises a third dielectric layer deposited so that the first metal layer is between the second and third dielectric layers, the third dielectric layer

comprising at least one infrared-absorbing material chosen from the group consisting of an oxynitride or a tetra-ethyl-ortho-silicate based oxide.

[c11] The infrared sensor according to claim 10, wherein the third dielectric layer comprises a tetra-ethyl-ortho-silicate based oxide layer and an oxynitride layer, the tetra-ethyl-ortho-silicate based oxide layer being closer to the first metal layer than the oxynitride layer.

[c12] The infrared sensor according to claim 11, further comprising a tungsten silicide layer between the tetra-ethyl-ortho-silicate based oxide layer and the oxynitride layer, the tungsten silicide layer increasing infrared absorption within a central absorption zone of the diaphragm aligned with the hot junctions of the thermocouples.

[c13] The infrared sensor according to claim 1, further comprising a heater element in the diaphragm and means for applying a current to the heater element to raise the temperature of the diaphragm.

[c14] An infrared sensor comprising:
a frame formed of a semiconductor material that is not heavily doped, the frame defining and surrounding a rectangular-shaped cavity;
a rectangular-shaped diaphragm suspended by the frame over the cavity, the diaphragm having a first surface within the cavity for receiving thermal radiation and an oppositely-disposed second surface, the diaphragm comprising a first dielectric layer, a sensing layer on the first dielectric layer and defining at least a pair of interlaced thermopiles, a second dielectric layer on the sensing layer, a first metal layer defining first metal conductors that electrically contact the thermopiles through openings in the second dielectric layer, a third dielectric layer on the first metal layer, a second metal layer defining second metal conductors that electrically contact the first metal conductors through openings in the third dielectric layer, and a fourth dielectric layer on the second metal layer, each thermopile comprising a sequence of thermocouples, each thermocouple comprising dissimilar electrically-resistive materials that define hot junctions located on the diaphragm and cold junctions located on the frame, the thermocouples being shortest at corners of the diaphragm and

progressively increasing in length therebetween so that substantially the entire diaphragm is occupied by either the thermopiles or a central heat-absorption zone surrounded by the hot junctions of the thermocouples;
a first metal body between the second and third dielectric layers for reflecting infrared radiation through the second dielectric layer so as to increase absorption of infrared radiation within the heat-absorption zone and thereby increase the temperature at the hot junctions of the thermocouples; and
signal processing circuitry on the frame and electrically interconnected with the thermopiles through the first metal conductors defined by the first metal layer and the second metal conductors defined by the second metal layer, the thermopiles being interlaced so that the output of a first of the thermopiles increases with increasing temperature difference between the hot and cold junctions thereof, and so that the output of a second of the thermopiles decreases with increasing temperature difference between the hot and cold junctions thereof.

[c15] The infrared sensor according to claim 14, further comprising:
a rectangular-shaped metal body between the third and fourth dielectric layers, the rectangular-shaped metal body surrounding the hot junctions of the thermocouples and being between the hot and cold junctions of the thermocouples to promote equalization of temperatures at an inner edge of the metal body and the frame; and
a tungsten silicide layer between the third and fourth dielectric layers so as to be surrounded by the rectangular-shaped metal body, the tungsten silicide layer increasing infrared absorption within the central absorption zone of the diaphragm.

[c16] The infrared sensor according to claim 14, wherein the signal processing circuitry comprises a serial bus interface and nonvolatile memory integrated circuit units that provide an on-chip calibration capability, and means for nonlinear temperature compensation responsive to changes in the temperature of the signal processing circuitry.

[c17] The infrared sensor according to claim 14, wherein the diaphragm further

comprises a polysilicon layer defining polysilicon conductors in parallel with the second metal conductors of the second metal layer, the polysilicon and second metal conductors defining coaxial conductors that electrically interconnect the thermopiles with the signal processing circuitry.

[c18] The infrared sensor according to claim 14, wherein the third and fourth dielectric layers comprise at least one infrared-absorbing material chosen from the group consisting of an oxynitride or a tetra-ethyl-ortho-silicate based oxide.

[c19] The infrared sensor according to claim 14, wherein the third dielectric layer comprises a tetra-ethyl-ortho-silicate based oxide and the fourth dielectric layer comprises an oxynitride.

[c20] The infrared sensor according to claim 14, wherein the signal processing circuitry comprises means for sensing the temperature of the frame.

[c21] The infrared sensor according to claim 14, further comprising a heater element that surrounds the central heat-absorption zone 30, and means for applying a current to the heater element to raise the temperature of the central heat-absorption zone.

[c22] The infrared sensor according to claim 14, wherein the infrared sensor is housed within a CERDIP package.